

LESLIE

ORGAN SPEAKER

"PIPE VOICE OF THE ELECTRIC ORGAN"

INSTRUCTIONS, SERVICE INFORMATION
AND PARTS LIST

Model 21 7

ELECTRO  MUSIC

PASADENA

CALIFORNIA

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SHIPPING INFORMATION

When the Leslie Organ Speaker is first unpacked from its original shipping box, take off the upper and lower compartment covers and remove the wooden shipping blocks from the upper and lower motors and the amplifier so that these units will float on their rubber mountings. Save the wooden blocks as they can be put back in place if the cabinet is shipped at some future time. Check to be sure the upper belt is in place on the rotor, idler and motor pulleys. Select the desired tremolo speed on the upper motor pulley. The center groove is the one most often used although slower or faster speeds are available by using the other grooves. The cabinet is then ready for use and the covers may be replaced.

For further handling, the cabinet may be moved or carried about without any preparations whatsoever unless it is to be shipped by truck or rail. When this is done, the original shipping blocks should be placed in the motor and amplifier mountings to prevent damage. The cabinet may be carried by hand in any position, but it should always be shipped in an upright position. Transporting the Leslie in a horizontal position carefully over short distances should do no harm, but it should not be subjected to severe jarring as in a trailer or truck while in that position.

INSTALLATION

For all larger Series Consoles With More Than One Octave of Pedals: These consoles are all equipped for external speakers, and therefore, may be attached to the Leslie by merely using the regular console cable furnished with the console and plugging it directly into the Leslie amplifier. The Leslie console tremolo control is then installed at the console as follows (series 2 and 3 consoles): Disconnect signal wires at G-G terminals on console preamplifier and connect these wires to screw terminals on the Leslie Type 2 Tremolo Control case. Connect the red and black wires from the control case to the G-G terminals on preamplifier where wires were removed. Connect yellow wire to any convenient ground screw. Select proper tube adapter for either 6x4 or 6x5 rectifier tube in preamplifier. Place adapter in rectifier socket and rectifier tube in adapter. Connect brown wire from Type 2 Tremolo case to the wire from the rectifier tube adapter (push insulating sleeve over terminal). On earlier model consoles, A, B, C, D, E, BV, and CV, which contain no rectifier tube in the preamplifier, connect brown wire from the Type 2 Tremolo case to the B+ terminal on preamplifier instead of using tube adapter.

With back of console removed, cut small notch in shelf to allow switch cord to enter interior, or as an alternate method, the manuals may be unbolted and lifted up, allowing the switch to be slipped underneath the manuals directly to the front rail so that the switch wire will be out of sight. To facilitate matters, the switch may be removed from the plastic case for this operation. However, it must be mounted back in the case in the same position as it was removed so that tremolo "on" and "off" will not be reversed. Attach switch case to wooden rail directly in front of lower manual. The most convenient location for the organist is usually to the left in front of the preset keys. The installation is then ready for operation.

SPINET MODELS—A convenient way to connect an external speaker to a spinet console is to use the Leslie Type 3M Echo Control, as this will provide the necessary connections, cables, and also allow the use of either the speaker mounted in the console, or the external cabinet, or both together. Complete information on installing both the 3M Echo Control and the Type 2 Tremolo Control and Leslie Speaker are found in this booklet under the heading "3M Echo Controls with Leslie 21H Cabinets".

TREMOLO SELECTION—Several plugs are provided in the amplifier so that various combinations of tremolo control may be obtained. Two of the motor outlets are controlled from the console tremolo switch and the other motor outlet is uncontrolled, remaining "on" at all times. These motor outlets may be identified by referring to the drawing on the back of the cabinet. By plugging both motors into the controlled outlets, both upper

and lower rotors will stop and start by operating the tremolo control at the console. If it is desired to control only one rotor, then that particular motor is left plugged into one of the controlled motor outlets and the other motor plug is placed in the uncontrolled socket so that it will continue to run. The standard arrangement preferred by many organists consists of plugging the upper rotor into one of the controlled sockets, and the lower rotor is placed in the socket that remains "on", thereby controlling the upper rotor only from the console. All speakers are shipped from the factory set up for this type of operation, but, of course, may be changed to other modes of operation by merely rearranging the plugs. If the tremolo control is not installed at the console, all motor outlets will remain "on", and therefore, may be used to supply the motors without any means of turning them off. If the lower rotor is to be controlled, it may be desirable to obtain an electric brake accessory that plugs into the amplifier, as this will stop the lower rotor in much less time than it would normally take to coast to a stop. A listing on this accessory is found in the parts list and more information will be found under the heading "Electric Brake."

IMPORTANT: If cabinets of another make or Leslies below Serial 5200 are added, a Leslie Type 2 Adapter must be used at each additional cabinet of this type to eliminate the control voltage. Use no adapters on any Leslie above 5200.

VOLUME CONTROL SETTING

A volume control is provided on front of amplifier near fuse holder, which will allow full power output without distortion with various consoles. In order to set this control properly, proceed as follows: Turn volume control to left as far as it will go (lowest volume); pull all drawbars out to position eight on one of the manuals and pedals; play full chords and pedal note with swell pedal completely open, advance volume control on amplifier until distortion becomes noticeable, then back the control off slightly to eliminate all distortion. This will be the proper setting and need not be further disturbed. Another use of the volume control is to turn down the volume where a maximum limit of loudness is desired. In an installation involving more than one speaker, the volume control is quite an advantage in balancing the sound level between the various speakers. In the case of two speakers, it is desirable to listen to approximately equal amounts of sound from each speaker for richest musical effects. A little experimenting with the balance between speakers is highly recommended.

Caution: Do not adjust volume control beyond the distortion point as continued use under overloaded conditions can cause damage to the speaker units.

USE OF TREMOLO CONTROL

If remote tremolo switch is used with standard arrangement of controlling only the upper rotor, separate effects for each manual may be obtained. This is done by choosing a stop with low upper harmonic content for one manual, such as the Tibia, and another stop with rich upper harmonic content for the other manual, such as string quality.

The Tibia may be played in the middle C range and will contain normal tremolo; whereas, if the string quality is played an octave or more above Middle C, it will have a very straight character with little tremolo, with switch in "off" position. Many organists find this to be very useful for certain types of church music.

It is readily seen that solos containing tremolo with straight type accompaniment, or vice-versa, are easily obtained. When the Leslie is used with consoles containing an electronic vibrato attachment, a particularly valuable combination is obtained with the conditions suggested above, plus the console vibrato knob on "No. 1" position.

Many interesting combinations of acoustical tremolo and electronic vibrato are available when using Leslies with Series "2" consoles because of the separate vibrato control for each manual. For instance, the Leslie tremulant in the upper range may be turned off, tremulant in the lower range left on, and electronic vibrato added to one manual only. The two types of treatment have good contrast because of their basic difference in vibrato development, and are found to be very useful. It is easily seen that a number of tremolo and vibrato combinations are possible that would not be available without the Leslie.

When using Leslie tremulants, the use of chorus and tremulant controls in early model consoles should be avoided as they tend to produce choppy and unmusical effects.

BROADCASTING AND RECORDING

For full, rich pipe-organ effects, the organ should be played at fairly high sound volume in a reasonably live studio with the microphone placed about ten or fifteen feet away from the speaker. Adjust height of microphone so that it is either above or below the upper louvers, as this will result in a smooth tremolo. When using two or more Leslie Speakers, they should be separated by at least ten or fifteen feet to derive the most benefit from a multiple installation. If two or more speakers are used in close proximity, they must be phased properly in order to obtain full pedal output. More information on phasing is included under the heading "Echo Controls and Multiple Speaker Installations".

MISCELLANEOUS

The Leslie Cabinet should rest firmly on the floor. It is not necessary that cabinet be absolutely level, but wedges should be placed under corner of cabinet that does not touch floor.

Due to the improved tonal characteristics of the Leslie Speaker, it is usually advisable to reset tone control in console for the most pleasing blend of tone.

In comparing depth of bass output with different consoles, some consoles do not have fundamental tones in the lowest pedal range, which may give the impression that the Leslie lacks bass.

Only one of the horns in the upper rotor assembly radiates sound. The other horn is for the purpose of dynamically balancing the assembly to eliminate vibration. A small cotton filter is placed in the throat of the horn for acoustic reasons and to prevent dust from entering the driver unit. Do not remove cotton filter.

The Leslie Organ Speaker incorporates many design features that improve the musical character of the Electric Organ, but these same features make it unsuitable for other purposes. For instance, it is not recommended that phonograph or radio signals be reproduced by the Leslie as undesirable results are almost a certainty. Using the Leslie as an amplifier for singing or reproducing other musical instruments also leads to unsatisfactory results. The reason for this is that the acoustical as well as the electric properties of the Leslie equipment are purposely different from what is considered desirable for other uses in order to produce the best possible conditions to enhance the musical quality of the Electric Organ.

If electrical or other laboratory measurements are made on the equipment, the comparison of such data to frequency response, phase shift, distortion, or other curves of other equipment will prove rather meaningless, since the Leslie design provides specialized performance that cannot be obtained with "High Fidelity" amplifying equipment.

OILING

There are three parts in the Leslie Speaker that require oiling. These are the upper motor, the upper tremulant rotor, and the lower motor. Since the bearings in all three components are self oiling with felt reservoirs, they require a minimum of care, but should be oiled regularly to obtain the maximum life. A bottle of high grade oil is furnished with each instrument that is sufficient for several years oiling. If this oil is mislaid or used, organ generator oil is excellent for the purpose and is highly recommended. For convenience in oiling, the bottle furnished has a built-in dropper and it is suggested that the bottle be refilled with generator oil when it is empty.

Each motor is fitted with a small oil pan that distributes oil to both bearings. An oil tube extends through the back of the cabinet for each motor so that the motors may be oiled without removing any covers. It is suggested that 20 or 30 drops of the oil furnished be placed in each of the oil tubes every six months for average use, and if this is done, many years service will result. For constant commercial use, more frequent oiling is desirable and the oiling procedure should be done twice as often. When the instrument has been in service for several years, or a reasonably long period in commercial use, better life will be obtained from the motors if they are removed from the cabinet and cleaned with cleaning solvent to remove accumulated dust that interferes with the proper ventilation and oiling. Since the motors may be removed in a few seconds, the investment in time to clean the motors is well repaid in longer life. To disassemble a motor, the pulley, pulley

support ring, and oiling tube assembly must first be removed before the motor can be completely taken apart.

The other assembly requiring oiling is the upper tremulant rotor. An oil hole is provided which leads to the felt reservoir for the bearing, and if about 5 drops of the oil furnished, or generator oil, is placed in the oil hole every year, long life is assured. Again for strenuous service in commercial use, oiling periods should be doubled. Allow the oil to drop into the oil hole slowly so as to have a chance to run down into the reservoir instead of overflowing at the top. The oil hole is found at the center of the bakelite tremulant assembly and is identified on the side that it is drilled. The other rotary parts, such as the upper idler pulley and lower tremulant rotor are permanently lubricated and do not require oiling.

BELT REPLACEMENTS

UPPER BELT—Remove upper compartment cover. Prestretch belt by pulling it out full length. Place it over one horn and then the other; then on desired motor pulley groove and idler pulley. Three tremulant speeds are available by choosing one of the grooves on motor pulley. Center groove provides standard tremolo, upper groove a slow tremolo, and lower groove a fast tremolo.

LOWER BELT—A badly frayed or worn lower belt may cause noise by striking the shelf or belt guard and should be replaced as follows: Remove large center back (eight screws) and lower compartment cover. Remove the eight screws in the rim of the bass speaker and also remove plug from dividing network case. Bass speaker may then be lifted from shelf and out of cabinet. (Lift straight up for a short distance to avoid cone damage.) Lift upper rotor support from shaft and then place new belt on large pulley and feed the rest of the belt between the rotor and shelf to the motor pulley. To facilitate belt replacement, motor may be removed or dropped down for better accessibility by unscrewing the two wing nuts so that the belt may be placed on the motor pulley easily. After motor is back in position, replace the rotor bearing support and position in the shallow groove on top of the shelf so that the holes are aligned. Next, place bass speaker back into position, first installing the two screws that hold the upper rotor support as well as the speaker. These screws should be just started in position and then the other six screws started. After all eight screws are well started, they may be tightened. Adjust belt tension next by loosening the front motor wing nut (the rear motor wing nut may be left tight) and pulling the motor assembly to the left until the belt is stretched. Release wing nut and belt will find its proper tension, then tighten wing nut. Do not attempt to stretch belt tight and hold in that position with wing nut, as noise and hard starting will result. Under average service, the belts usually last several years and in the event of any excessive belt wear, the pulley and mountings should be inspected for rough surfaces or misalignment that may cause the wear.

Amplifier is removed from cabinet by taking out the one screw that holds the front end of the amplifier to the bottom of the cabinet. After the two motor plugs and speaker plugs are removed, the amplifier may be withdrawn. When pushing the amplifier back into place, align the back end of the chassis in approximate position so that the amplifier guide and holddown clamp will engage the amplifier.

FUSES—The two ampere fuse on the front of the amplifier protects the power supply against most short circuits. If this fuse is blown, the most common cause is a shorted tube or filter condenser. Therefore, the tubes and filter condensers (the round plug-in unit) should be checked if two ampere fuses are blown. Amplifiers are shipped from the factory equipped with "Slo-Blo" two ampere fuses that will not blow out with occasional heavy line surges. If regular two ampere fuses blow out for no apparent reason, there are probably heavy line surges present. In such cases, the two ampere "Slo-Blo" fuse should be used. A heavier fuse such as a three ampere should not be used as no protection will be afforded in certain shorts that may occur in a tube, and to use a heavier fuse may only result in damage to the power transformer or other components.

A second fuse is found inside the amplifier which is a one-quarter ampere pigtail unit wired into the circuit, and in the event the two ampere fuse in front of the amplifier does not blow out, but this quarter ampere pigtail fuse blows, it is an indication that a secondary short exists in the speaker field coil, field coil wiring, or output tube screen circuits. By virtue of the two fuses provided in the amplifier, costly repairs are almost certainly avoided, and if proper size fuses are always used, serious damage to amplifier parts will be avoided.

TUBES—Tubes are probably the most common source of amplifier difficulties, and while they may be checked in a tube checker, this does not always reveal all of the tube faults. The surest method of checking is to substitute another set of tubes so as to eliminate these units as a possible source of trouble. For reliable operation, it is generally recommended that the tubes be replaced after they have given one thousand hours service, as in this way, difficulties may be avoided. Sometimes even new tubes are not uniform and may cause hum or other troubles, and therefore, if difficulties arise at the time tube replacements are made, the new tubes should be carefully checked or substituted. Badly mismatched 6V6 tubes may cause hum and distortion and should be either switched around for the best results, or the offending tubes replaced.

ELECTROLYTIC CONDENSERS—Practically all modern amplifiers contain electrolytic condensers which have a definite life, and therefore, must be replaced eventually. The electrolytic condensers used in Leslie amplifiers are the finest available, and experience has shown that many years' service can be expected. However, in view of the fact that they will eventually wear out, all of the electrolytic condensers are contained in a single plug-in unit that may be replaced as easily as a tube. The condenser is a three section 30-30-10 mfd. 450 volt unit obtainable from the factory or many parts supply houses. In the event trouble develops in this unit, it is suggested that it be removed from the amplifier by merely pulling it out of the socket, and taken to a radio parts supply house for duplication.

TREMOLO CONTROL—In the event the tremolo control does not operate properly, the switch equipment installed at the console should be checked over very carefully to be sure that the installation is correct, since any deviation will result in improper operation. Also make sure that the cable contains no short circuits or unusual conditions that would upset the voltage applied to the signal line. If another make cabinet or echo switch is involved, the line must be checked to be sure that there are no unusual circuits which would ground the tremolo control voltage applied at the console. If all of the above points appear to be cleared, then the entire tremolo circuit, both at the console and in the Leslie amplifier, should be carefully checked against the diagram to reveal the conditions that prevent proper operation of the control device..

TREMOLO CONTROL - EXPLANATION OF OPERATION—The Leslie amplifier includes a tube operated relay circuit to control the tremulant motors from a switch at the console without adding any wires from the console to the speaker cabinet. A 6J5 tube is used, with a relay coil and current limiting resistor connected in the plate circuit. The cathode of the 6J5 is connected to the cathodes of the 6V6 tubes which are at about 19 volts positive. This cathode voltage cuts off the plate current in the 6J5 when the grid is held at ground potential. The grid is connected to the signal line through a one megohm isolating resistance. When the potential of the signal line is raised to a positive value greater than 19 volts, the grid voltage will be brought to zero with respect to the cathode (the one megohm resistor will prevent the grid from being driven positive) the 6J5 tube will draw plate current, and the relay will operate.

The Tremolo Control Type 2 which is installed at the console contains a DC isolation transformer so that a positive voltage may be applied to the signal line at the center tap of the line transformer. A 10 mfd. condenser at the center tap keeps the entire signal line at low impedance to ground, and at the same time, allows a change in DC potential. Because of the one megohm resistance in the grid of the 6J5 control tube, the line is not affected from a signal standpoint, also the amount

of DC voltage to operate the circuit is not critical and the apparatus will operate over wide variations in B+ voltage and AC line voltage. A dropping resistor is placed in the tube adapter which is used to pick up B+ in all series 2 and 3 consoles; this resistor also produces the power supply in case of an accidental short circuit.

TYPE 2 ADAPTER—If speaker cabinets other than Leslies above serial 5200 are used with the Model 21 H, a Leslie Type 2 Adapter must be employed at each such cabinet to remove the tremolo control voltage from the amplifier tubes, otherwise improper operation of these extra cabinets will result from the control potential on the signal line. A circuit diagram of this adapter is found on the diagram page of this booklet. An alternate method would be to install isolating condensers in the grid circuits as is done in the 21 H so as to eliminate the control voltage, although the application of the Type 2 Adapter is a simple and inexpensive solution that may be easily removed when not required. If condensers and resistors are added to other amplifiers, use 1.0 mfd. and 50,000 ohms for best results, as these values will be satisfactory for all standard amplifiers generally used.

LINE VOLTAGE—Either exceptionally low or high line voltage may cause difficulties with the amplifier operation. Exceptionally low line voltage may be experienced due to poor contacts in the cable wiring or exceptionally long cables. If the line voltage falls below 100 volts, unsatisfactory performance will probably result, both in amplifier output and tremolo control operation. This condition must be corrected by using heavier cable or some type of line voltage regulator before satisfactory operation can be obtained.

High line voltage, as well as low line voltage, will reduce tube life and in the event of exceptionally high line voltage (above 125 volts), the amplifier will run quite hot, resulting in shorter tube and condenser life. A line voltage regulator must be used where high line voltage conditions are prevalent. In checking line voltage, the measurement should be made at the speaker cabinet amplifier to avoid erroneous readings due to voltage drop in the cable etcetera.

NOISE CHECKING—In the event a continuous noise is persistent when the console is turned on but not played, the source of the noise or hum may be generally determined by short circuiting the two large prongs on the Leslie amplifier input plug while the equipment is in operation. If the noise disappears when these two prongs are shorted, it usually indicates that such noise originates in the console or cable wiring, and not in the Leslie Speaker or amplifier. If the noise persists even though the two large prongs are short circuited, then it is usually a certain indication that the noise developed is contained in the Leslie Speaker, and such things as tubes and coupling condensers must be checked to determine the source of the noise.

AMPLIFIER IN GENERAL—Amplifier gain is purposely greater than usually necessary so that full power output may be obtained from weak consoles, and under normal conditions, the volume control is rarely at maximum. To arbitrarily place the volume control at maximum will almost always result in distortion if the organ volume is brought to maximum, and therefore, it is important to adjust the volume as described on the back of the cabinet. If the output transformer is replaced, the two plate leads should be as short as possible and lie close to the chassis. While replacement transformers, filter chokes, and relays should be obtained from the factory, fuses, sockets, resistors, and condensers may be obtained from radio parts supply stores. The bass speaker field coil measures about 2650 ohms cold, and when warmed up to operating temperature, around 3100 ohms.

If greater high frequency output is desired to produce "brighter" results even though the tone control on the console is turned all the way up, the .0047 mfd. condenser in the Leslie amplifier (6V6 plate to plate) may be removed and replaced with a .0025 mfd. or .003 mfd. which will about double the output power at the highest range. This condenser should not be left entirely off however, since this would increase key "pop" and other noises without increasing the musical output on the high range appreciably.

If the amplifier develops difficulties resulting in unsatisfactory or no operation that is not remedied by tube or electrolytic condenser replacements, the various voltages should be measured and compared to the voltages shown on the circuit diagram. The voltages indicated were measured with a 1000 ohms per volt voltmeter, and differences in meter resistance and line voltage variations as well as parts tolerances should be kept in mind. If any abnormally high or low voltage is noted, it usually indicates a defective part in the associated circuit.

DIVIDING NETWORK—A dividing network, consisting of coils and condensers, is used to separate the bass and treble output of the amplifier and direct it to either the treble speaker or the bass speaker. This unit is mounted in the center compartment or bass reflex section. Both speaker units plug into the dividing network, and in turn, the dividing network plugs into the amplifier. If the dividing network is suspected of causing low output in either or both ranges, this may be easily checked by plugging the bass speaker directly into the amplifier, as the voice coil and field circuits will still be complete. While the musical quality will be quite inferior to the regular plug connections, the speaker cabinet may be used on an emergency basis in this manner with the treble speaker and dividing network not operating.

LESLIE 2H ELECTRIC BRAKE—The 2H Electric Brake plugs directly into a socket provided in the 21H amplifier. The brake unit consists of rectifiers and a thermal relay that places a DC current through the motor windings for a period of about eight seconds after the tremolo control is turned off. This DC current effectively holds the motor shafts from turning, which slows the rotors down quickly. The thermal relay tube may be re-

placed in the same fashion as a tube, but is only obtainable from the factory since it is of special design. A schematic diagram on the electric brake is found on the diagram page of this booklet.

CONSTRUCTIONAL INFORMATION

TO REMOVE UPPER MOTOR:

Remove the two wing nuts and motor plug from socket, and motor may be lifted out of cabinet. Upper and lower motors are completely interchangeable if the proper pulley is used.

IMPORTANT: The upper motor must run counter-clockwise when viewed from the pulley end, as otherwise the upper tremulant rotor will not come up to speed. If the motor is disassembled or another motor substituted, the rotation should be checked to be sure it is counter-clockwise.

TO REMOVE LOWER MOTOR:

Remove the two wing nuts that hold it to the shelf, and the motor plug from the amplifier, and motor will drop down for removal. When replacing this motor, first place the belt on the motor pulley before it is lifted into place on the mounting screws. Since the front wing nut controls the belt tension, the belt must be adjusted whenever the motor is removed. To do this, pull the front wing nut to the left until the belt is tight, then release. Tighten in this position. Too much tension is unnecessary and may result in noise or slow starting. If a Leslie Electric Brake is used, the belt tension adjustment should be made carefully to obtain the best use of the brake. If the belt is adjusted properly, some slipping will be heard when the motor starts and stops. Do not tighten the belt sufficiently to eliminate all slippage, as this will interfere with the proper operation. Upper and lower motors are completely interchangeable if the proper pulley is used. Motor pulley is held on to the shaft by the center screw and after this is removed, the pulley may be pulled from the shaft. Center distance between holes in mounting brackets is $5\frac{7}{8}$ inches and if brackets are bent, they should be straightened to this measurement.

TO REMOVE TREBLE SPEAKER UNIT AND/OR UPPER TREMULANT ROTOR:

1. Remove upper cover and belt.
2. Remove center compartment back (8 screws).
3. Remove treble speaker unit plug from dividing network.
4. Remove the three screws in the rim of the treble speaker unit and drop straight down and out. The upper tremulant rotor may be removed by turning it sideways.

IMPORTANT: When replacing these parts, be sure the rubber and metal thrust washers are on the spindle so that the tremulant rotor will operate at the correct height and bass tones will not produce thrust bearing noises. The rubber washer is first placed on the spindle and then the metal washer with the polished side of the metal washer at the top.

IDLER PULLEY—The spring mounted idler pulley provides proper belt tension, and in the event the spring mounting becomes bent, it should be readjusted by bending so that it is aligned with the belt.

TO REMOVE BASS SPEAKER:

1. Remove center compartment back (8 screws) and screws in rim of bass speaker. Lift bass speaker straight up for a short distance before withdrawing from cabinet so as to avoid damage to the cone.

TO REPLACE LOWER ROTOR BEARINGS:

Upper bearing:

1. Remove bass speaker.
2. Remove top half of bearing clamp and ball bearing may be lifted off and replaced.

If new bearing is found to be slightly loose in the bearing clamp after the nuts are tightened, this may be corrected by bending the lower half of the bearing clamp so that it will apply more pressure to the ball bearing assembly. (Remove the complete bearing support to facilitate this adjustment.)

Lower bearing:

1. Place cabinet on floor so that bottom is accessible.
2. Remove the two screws that fasten the bearing mounting plate to the cabinet and entire bearing assembly may be pulled from shaft.
3. Bearing may be replaced by using the same technique as in the upper bearing.

NOTE: Be sure flat metal washer is in place on bottom of rotor grommet as the rotor rests on this washer and the position of the rotor is dependent on the washer being in place.

TO REMOVE LOWER TREMULANT ROTOR:

1. Remove bass speaker.
2. Remove upper bearing support and belt.
3. Remove tremulant rotor shaft by twisting and pulling up at the same time using the pulley as a handle. The tremulant rotor may then be withdrawn from the cabinet to the rear. When replacing the rotor and rotor shaft, a little oil or vaseline on the shaft will facilitate matters. Rubber parts are neoprene and will not be damaged by oil.

As the shaft is inserted, the rotor must be held in a position that will allow the lower shaft end to enter the grommet in the center of the bearing. To simplify the alignment of the shaft with the lower bearing, it may be easier to place the cabinet on the floor and remove the lower bearing assembly as in replacing the lower bearing. Also, in this way, it can be determined that the washer between the ball bearing grommet and the tremulant rotor grommet is properly in place.

ECHO CONTROLS AND MULTIPLE SPEAKER INSTALLATIONS

MULTIPLE SPEAKER INSTALLATIONS WITHOUT ECHO CONTROLS—Results obtained from the use of one Leslie are usually quite satisfactory, but a surprising amount of added grandeur and fullness can be achieved from the use of two or more units. One speaker might be compared to a pipe organ with one chest of pipes, whereas adding Leslies tends to create the effect of additional chests of pipes. Even though more power is not always desired, two speakers are often employed for the extra musical characteristics. For best results, multiple speakers should be separated by at least fifteen or twenty feet, and dif-

ferent tremulant speeds for each speaker (by belt adjustment) can be chosen so as to get the intermingling tremolo effects so characteristic of large pipe organs. Sound output from each speaker should be balanced by means of the volume control in the amplifier so that listeners will hear some sound from each cabinet.

Additional speakers are connected by means of jumper cables from speaker to speaker. These may be five wire cable with a six contact socket on one end and five prong plug on the other. If regular organ cable is used, connections are as follows: Blue and grey wires (115 volt AC) connected to terminal 3 and 4 of the six contact socket, pins 2 and 4 of five prong plug. Red and black wires (signal) connected to contacts 1 and 6 of socket, pins 1 and 5 of five prong plug. Connect yellow wire (ground) to number 2 contact of socket and number 3 pin of plug.

When connecting more than two Leslies to a single console, a separate 115 volt AC supply must be used for the additional speakers so as to avoid overtaxing the console switch and cable. The method of connecting additional speakers is as follows: Five-wire jumper cables with regular five prong plugs and six contact sockets should be made to interconnect the additional speakers; when the six contact socket is attached to the cable, do not connect the AC wires to pins number three and four, but attach these to the coil of a 115 volt AC relay; connect a separate pair of wires to these contacts three and four; and break one side of this line with the relay contacts. Connect this line to a separate 115 volt outlet.

In this manner, the extra speakers are automatically turned on and off when the console is turned on and off without the power load running through the console circuits. The tremolo control circuit in all of the extra Leslies (above serial 5200) will operate from the console tremolo switch if the installation is made as suggested above.

If two speakers are connected to a console and placed adjacent to each other, they must be phased so that the pedal frequencies will add instead of subtract. This can be accomplished by reversing the signal leads (red and black cable wires) at either of the speakers. Connect these wires for loudest pedal output.

ECHO CONTROLS

NOTE: If echo controls other than Leslies are used, they must be of the ungrounded type since grounds in the echo switch wiring will interfere with the proper operation of the tube operated tremolo control circuit in the Leslie 21 H. Those echo controls containing grounded circuits may be converted to the ungrounded type by using the echo control circuit found in this booklet.

3H ECHO CONTROLS WITH LESLIE 21 H CABINETS—The 3H Echo Control is designed for use with all larger series consoles (use 3M Echo Control for Spinnet Consoles) and may be used to connect two speaker cabinets or two groups of speaker cabinets in almost any fashion. If two Leslie Speakers (above serial 5200) are to be used for both "Main" and "Echo", proceed as follows: The tremolo control switch is installed at the console in the usual way with the red and black wires connected to the preamplifier G-G terminals and

the Leslie Type 3H Echo Control added. The red and black wires from the echo terminal box are placed on the screw terminals of the tremolo control case. The red and black wires from the "Main" and "Echo" speaker cabinets are then connected to the screw terminals marked "Main" and "Echo" on the echo control terminal box. The regular console cable is used for one of the speaker cabinets and another five wire cable made up for the additional cabinet. (Six-conductor cable may be used by cutting the brown wire short and leaving disconnected at both ends.) The additional cable is prepared with a six contact socket on one end and spade lugs on the other. The 115 volt AC (grey and blue) wires and the ground wire (yellow) are connected to the same terminals as the main speaker cable. The red and black (signal) wires are connected as described above. The installation just outlined will control the tremulants in both cabinets together from the one tremolo control switch.

If it is desired to control tremulants in "Main" and "Echo" speakers from separate tremolo switches, this may be done by installing two Type 2 Tremolo Controls. Both yellow wires are grounded, and both brown wires are connected to the B+ supply. On Series "2" Consoles, only one tube adapter is used since both brown wires may be connected to the screw terminal on one adapter. Both red wires from the tremolo controls are connected to one of the "G" terminals on the preamplifier, and both black wires to the other "G" terminal.

The Leslie Echo Control Type 3H is then modified as follows: Remove bottom plate and disconnect one pair of the 820 ohm resistors that lead to the screw terminals marked "Echo". Leave the ends of the resistors connected at the screw terminals, but disconnect or cut off the other end near the soldering lugs. Solder another pair of wires to the free ends of these resistors and insulate the connections. Push the wires through the same hole with the black and red wires. Connect the original red and black wires to the screw terminals on one Tremolo Control terminal box, and the other pair (new wires added to Echo Control) to the other Tremolo Control terminal box. Each tremolo control will then operate one cabinet only.

If one Leslie Cabinet and one cabinet of another make are to be used as the "Main" and "Echo" cabinets, proceed as in the case of using two Leslie Cabinets with one tremolo control. However, a Type 2 Adapter must be used at the other make cabinet to eliminate the tremolo control voltage as previously described. At any time, another Leslie Cabinet may be substituted and the installation will work perfectly by merely removing the Type 2 Adapter.

3M ECHO CONTROLS WITH LESLIE 21 H CABINETS—The 3M Echo Control is designed for use with the Spinet Consoles and provides means to easily connect external speakers to these consoles.

Mount equipment as follows:

1. Remove switch from plastic case by pulling off lever button and removing two mounting screws. Mount plastic case in position on

keyboard rail to the right as far as it will go, as this is a convenient position for the organist.

2. As viewed from the back of the console, mount terminal box on left side of console case at a level slightly above the power transformer of the amplifier. Push switch and cable through opening on left above generator cover that leads to space underneath manuals. Mount switch back in plastic case making sure that open side of switch (side with part number stamp) faces curved surface of plastic case.
3. Secure six-conductor speaker cable near right hand lower corner of console case with clamp supplied.

Connect wiring as follows:

1. Remove console speaker voice coil leads from amplifier and connect to terminals on ends of yellow wires. Insulate with sleeves provided.
2. Connect red wires to terminals at amplifier marked "Voice Coil". Leave black wire disconnected and insulate with tape, except on Model M Consoles below serial 3000, ground this wire to amplifier chassis.

3. Connect six-conductor speaker cable as follows:

Grey and blue wires to AC connections on amplifier marked "Grey" and "Brown".

Yellow wire to ground on amplifier (use screw on terminal cover over AC connections). If cable contains a brown wire, leave disconnected and insulate with tape.

Instructions for connecting the red and black wires are covered in the installation of the Type 2 Tremolo Control. In case the Type 2 Tremolo Control is not used, or the 3M Echo Control is used to connect cabinets other than Leslies above Serial 5200, the red and black speaker cable wires are connected to the terminals on the echo terminal box marked "Echo".

The Type 2 Tremolo Control Installation:

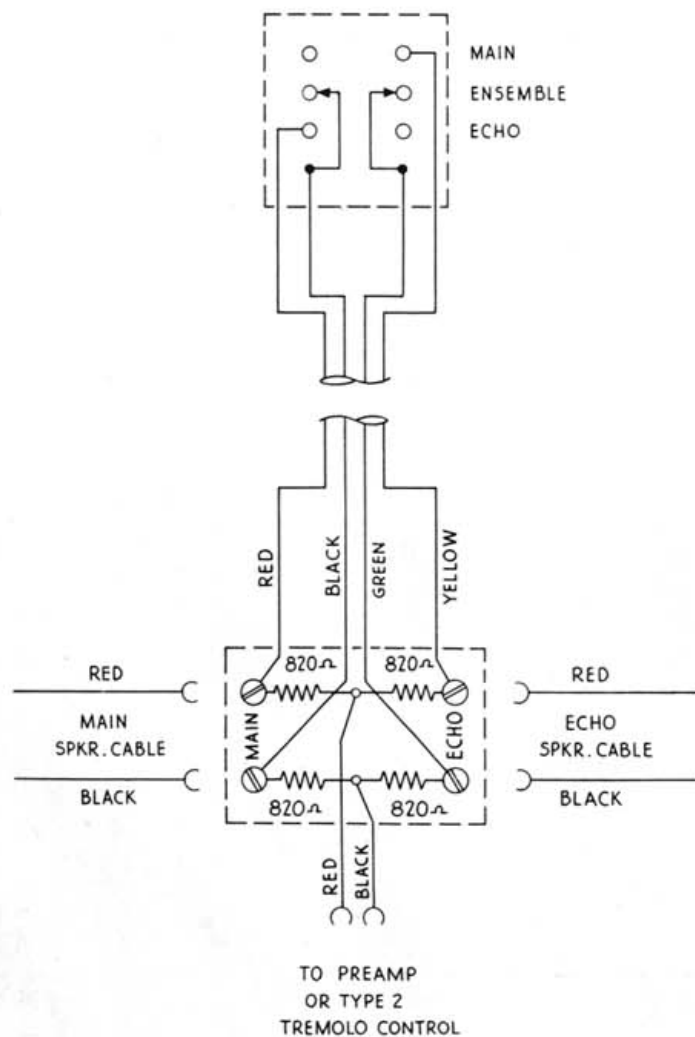
1. Connect the red and black speaker cable wires to the screw terminals on the tremolo control case.
2. Connect the red and black wires from the tremolo control case to the screw terminals marked "Echo" on the 3M Echo Control.
3. Connect yellow wire from the tremolo control to any convenient ground screw on console amplifier.
4. Connect brown wire to octal tube adapter furnished (push insulating sleeve over terminal). Place octal adapter in 5U4G socket and 5U4G tube in adapter.

The installation is then ready for operation.

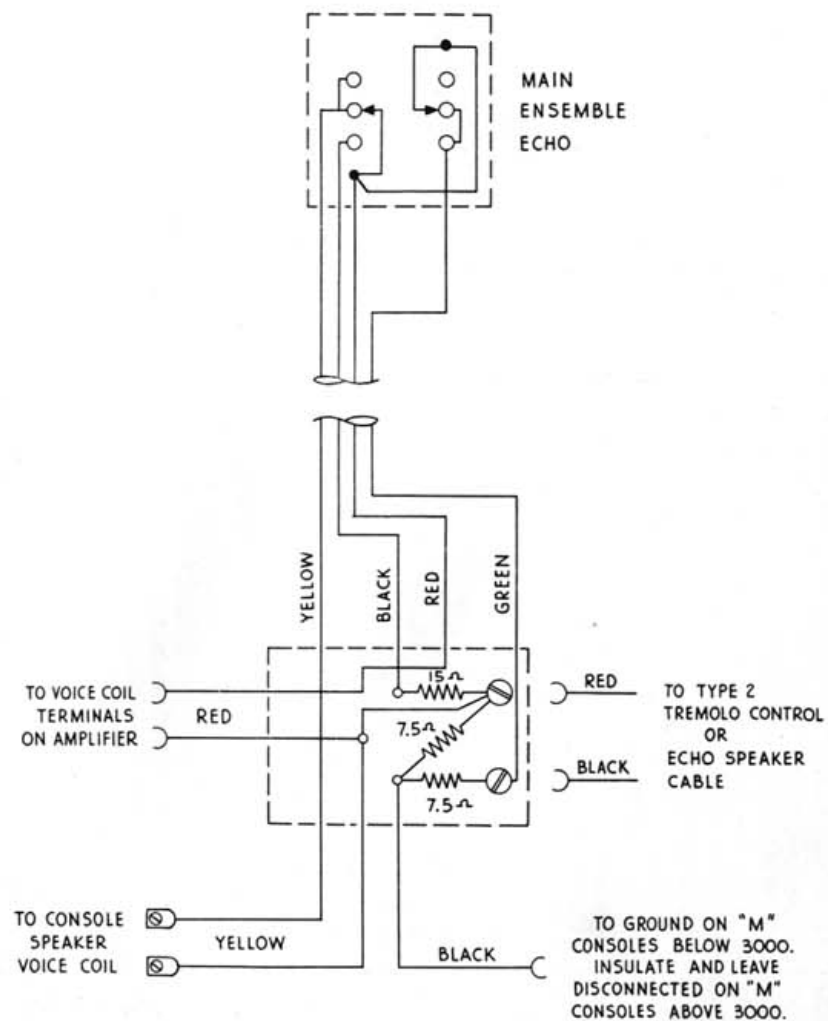
IMPORTANT: Adjust volume control on speaker cabinet as per instructions on back of cabinet to obtain proper results without distortion.

LESLIE ECHO CONTROLS

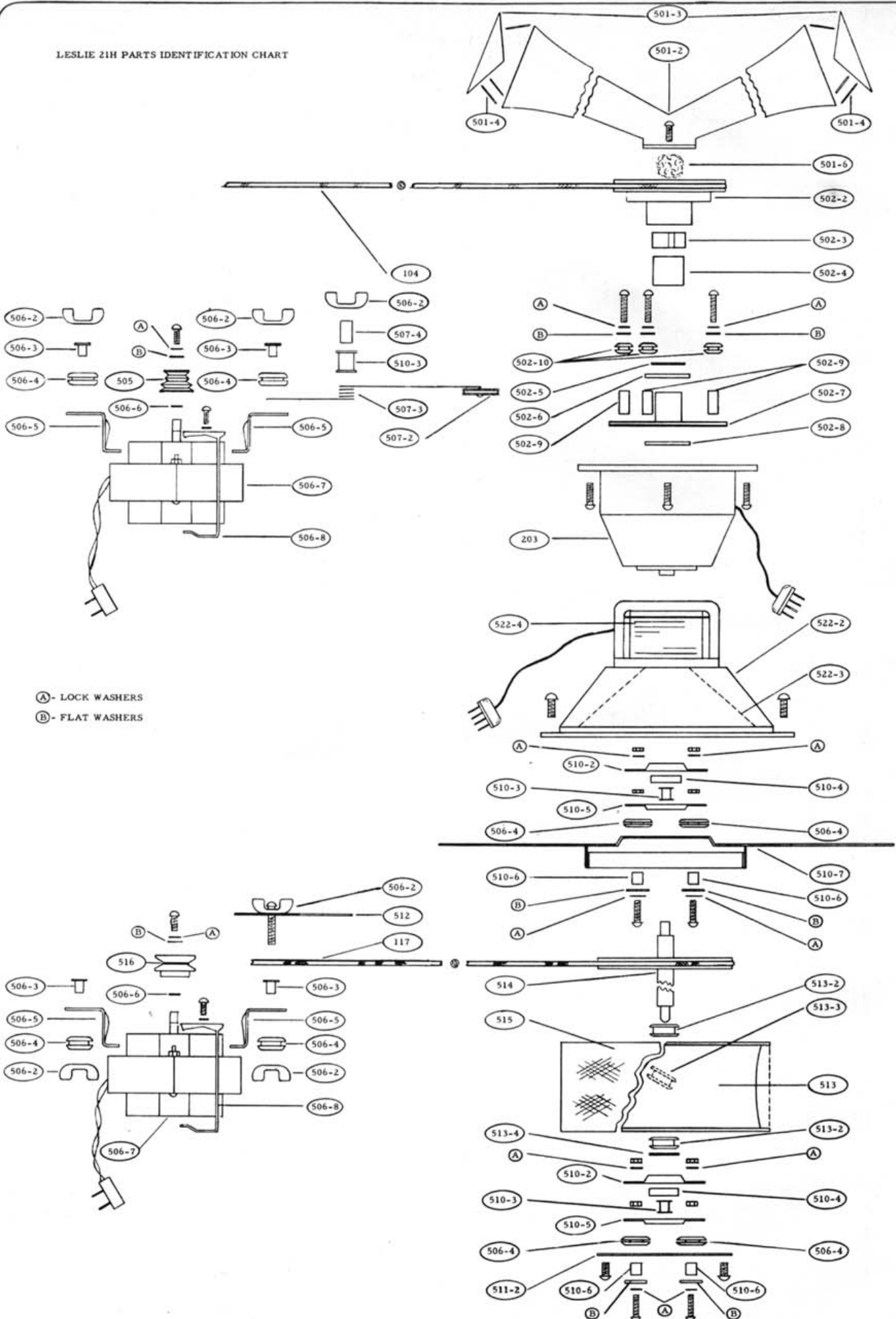
TYPE 3H



TYPE 3M



LESLIE 21H PARTS IDENTIFICATION CHART



LESLIE MODEL 21H PARTS LIST

IMPORTANT: When ordering parts, serial number of instrument must be furnished to insure correct parts being supplied.

Part numbers of three digits are complete assemblies. Part numbers with dash numbers (Example: 501-3) are individual parts from complete assemblies. To order complete assemblies, use only the three digit number. (Example: for complete motor assembly, order part no. 506.)

501	TREBLE HORN ASSEMBLY	117	BASS ROTOR BELT
501-2	Bakelite horn casting only	510	BASS ROTOR SUPPORT ASSEMBLY, UPPER
501-3	Horn reflectors (2 used)	510-2	Bearing clamp, upper half
501-4	Reflector mounting pins (6 used)	510-3	Rubber grommet
501-5	Special cement	510-4	Ball bearing
501-6	Cotton filter	510-5	Bearing clamp, lower half
502	SPINDLE AND HORN PULLEY ASSEMBLY	510-6	Metal bushing (2 used)
502-2	Treble horn pulley	506-4	Rubber grommet (2 used)
502-3	Felt oil reservoir pad	510-7	Crossbar support
502-4	Bearing sleeve	513	BASS ROTOR (With grommets, less cover)
502-5	Metal thrust washer	513-2	Rubber grommet (ends, 2 used)
502-6	Rubber thrust washer, 1-1/16" hole	513-3	Rubber grommet (center)
502-7	Spindle and mounting plate	513-4	Metal washer
502-8	Rubber spacing washer 5/8" hole	514	BASS ROTOR SHAFT AND PULLEY
502-9	Spacer, spindle mounting (3 used)	515	BASS ROTOR CLOTH COVER
502-10	Rubber grommet (3 used)	511	BASS ROTOR SUPPORT ASSEMBLY, LOWER
203	TREBLE SPEAKER UNIT	510-2	Bearing clamp, upper half
104	TREBLE ROTOR BELT	510-3	Rubber grommet
507	TREBLE ROTOR IDLER PULLEY ASSEMBLY	510-4	Ball bearing
507-2	Pulley wheel	510-5	Bearing clamp, lower half
507-3	Spring	510-6	Metal bushing (2 used)
507-4	Metal bushing	506-4	Rubber grommet (2 used)
510-3	Rubber grommet	511-2	Lower support mounting plate
506-2	Wing nut	512	ADJUSTABLE MOUNTING PLATE, LOWER MOTOR
505	THREE STEP MOTOR PULLEY		AMPLIFIER
506	MOTOR ASSEMBLY, LESS PULLEY (Same assembly, upper and lower)	525	21 H AMPLIFIER COMPLETE WITH TUBES
506-2	Wing nut (2 used)	525-5	Chassis mounting strip (2 used)
506-3	Metal shoulder bushing (2 used)	525-6	Rubber shoulder bushing (4 used)
506-4	Rubber grommet (2 used)	525-7	Metal bushing (4 used)
506-5	Bracket (2 used)	525-8	Amplifier hold down clip (front)
506-6	Pulley support wire ring	525-9	Power transformer
506-7	Motor only	525-10	Output transformer
506-8	Oiling tube	525-11	Filter choke
522	BASS SPEAKER	525-12	Relay
522-2	Cone and frame assembly	510-6	Relay mounting bushing
522-3	Cone only for replacement in frame	502-10	Relay mounting rubber grommet
522-4	Field coil only	525-13	Motor outlet socket (3 used)
516	SINGLE GROOVE MOTOR PULLEY		

- 525-14 Speaker socket
 525-15 30-30-10 mfd. 450V plug in condenser
 525-16 Fuse holder
 Other parts such as resistors, condensers, and sockets available from radio stores.

527 DIVIDING NETWORK, COMPLETE

MISCELLANEOUS PARTS

- 526-19 Upper back cover
 526-10 Plastic oil tube
 526-21 Lower back cover

530 BOTTLE, LUBRICATING OIL

SCREWS

Thread and length	Quantity and where used
6/32x1/4"	(2) Fasten 429-1 or 3H-5 to 428-3 or 3H-2 (state black or nickel)
6/32x1 1/8"	(3) Fasten 502-7 to 203
6/32x3/8"	(2) Fasten 501 to 502-2
8/32x7/8"	(4) Fasten bearing clamps to supports
10/24x3/8"	(2) Fasten bass rotor lower support
10/24x7/8"	(1) Fastens amplifier to cabinet
10/24x1"	(1) In slot of 512 (place in 506-2 wing nut)
10/24x1 1/4"	(8) Fasten 522 to shelf
10/24x1 1/2" (black)	(12) Fasten backs to cabinet
10/24x1 3/4"	(3) Fasten 203 to shelf
10/32x1"	(4) Fasten 525-5 strips to amplifier
#10x7/8" sheet metal	(2) Fasten 512 to shelf
10/24 "T" nuts	Used throughout cabinet construction

CONTROLS AND ACCESSORIES

428 TYPE 2 TREMOLO CONTROL COMPLETE

- 428-2 Tremolo control transformer only
 428-3 Plastic tremolo switch case only (brown)
 428-4 Plastic tremolo switch case only (white)
 428-5 Plastic tremolo switch case only (black)
 428-6 Push-on knob (brown)
 428-7 Push-on knob (black)
 429-1 Tremolo electrical switch only

2H ELECTRIC BRAKE, COMPLETE

- 2H-2 Thermal relay tube
 2H-3 Selenium rectifier (2 used)

3H ECHO CONTROL, COMPLETE (for large consoles)

- 3H-2 Plastic echo switch case (brown)
 3H-3 Plastic echo switch case (white)
 3H-4 Plastic echo switch case (black)
 428-6 Push-on knob (brown)
 428-7 Push-on knob (black)
 3H-5 Echo electrical switch only

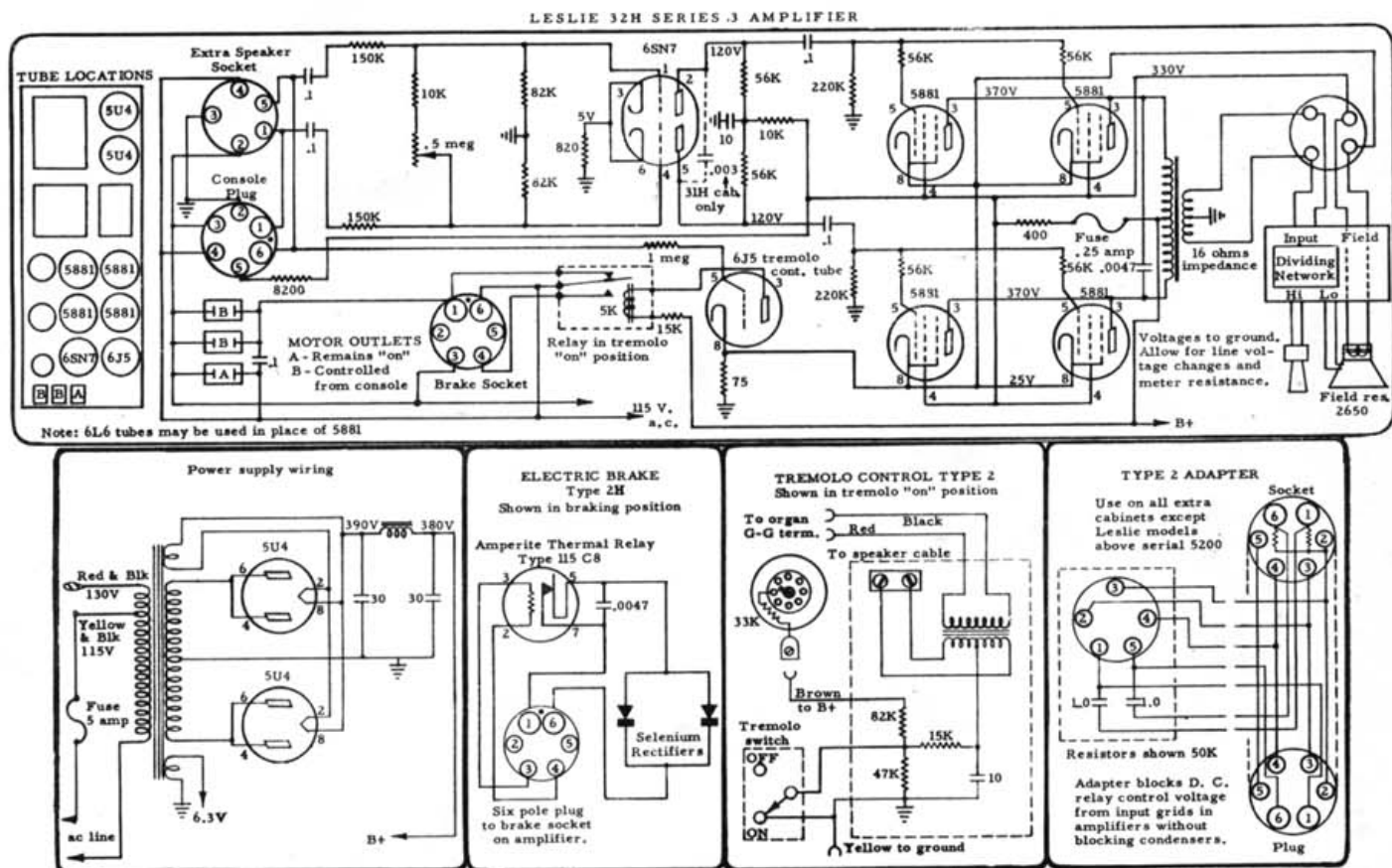
3M ECHO CONTROL COMPLETE (for Spinet Consoles) Use 3H parts list to order switch cases and switch parts.

TYPE 2 ADAPTER, COMPLETE

5A LESLIE POWER RELAY (Furnishes power to extra speaker cabinets, plug-in type, no installation required.)

LESLIE MODEL 21H

EQUIPPED WITH 32H SERIES THREE, 30 WATT AMPLIFIER



Use regular 21H parts list except as follows:

- | | |
|-------|--------------------|
| 425-1 | Power Transformer |
| 425-2 | Output Transformer |
| 425-3 | Filter Choke |

NOTE: Be sure .003 mfd. condenser on 6SN7 plate to plate indicated on diagram is in place when 32H amplifier is used in 31H cabinet and removed when used in 21H cabinet.





